



02/06/2009

Application NO. 10/078,299

Name of Applicant: Ying Liu

Name of Examiner: Rosario, Dennis

CLAIM AMENDMENTS

Please amend the claims as follows:

35. (Currently amended) A process for recognizing an image, said process comprising:

Imposing an image to an ABM so the ABM will be trained, whereas the ABM is a specific combination of (a) a fully connected neural network and (b) a Markov chain;

Classifying at least one target image based on the invariant distribution function of the trained ABM;

Imposing an image to an APN so the APN will be trained, whereas the APN is a specific combination of (a) a fully connected neural network, (b) a Markov chain, and (c) a mapping function;

Classifying at least one target image based on the invariant distribution function of the trained APN.

36. (Currently amended) The process of Claim 35, wherein the step of training an ABM comprises:

- a) Deleting the existing ABM connections.
- b) Combining an image and its classification(s) into an input vector.
- c) Calculating the ABM neural connections based on the input vector. Let N be the number of neurons, these connections can be up to the order of N . The input image is randomly broken down into a predefined number of pieces.
- d) Constructing a neural state vector for each piece of an image as follows: let an image piece, p_1 , have $K = (k_1 + k_2)$ pixels, where K is an integer. After imposing the pixel vector to the ABM net, k_1 is the number of neurons excited and k_2 is the neurons of neurons grounded. A neural state vector can be constructed to represent such a configuration, which k_1 components being 1, and k_2 components being 0.

- e) Constructing a connection space and the first connection vector within this space as follows: all neuron configurations together form a space, the configuration space. All neuron connections together form a space, the connection space. Now make the configuration vector = connection vector = p_1 , which results in the first synaptic connection matrix element.
- f) Calculating the rest of the matrix elements is based on a distance in the configuration space, either the Hausdorff distance or L1 distance or L2 distance, and the first matrix element calculated in the last step. Many connection vectors will be in a group with a distance of 1 from p_1 . Many vectors will be in a group with a distance of 2 from p_1 . A connection represented by p_1 is assigned the largest value. Those connections in the group of distance 1 will have smaller values than the first synaptic connection matrix element; those connections in the group of distance 2 will have even smaller values, After a certain distance, the connection matrix elements will be 0. There are many ways to generate these matrix elements from the first matrix element. The present invention covers all possible combinations of such a generating method.
- g) Constructing a Markov chain after the connections are established.

37. (Currently amended) The process of Claim 35, wherein the step of training an APN comprises:

- a) Deleting the existing ABM connections.
- b) Combining an image and its classification(s) into an input vector.
- c) Calculating the ABM neural connections based on the input vector. Let N be the number of neurons, these connections can be up to the order of N . The image is randomly broken down into a predefined number of pieces.
- d) Constructing a neural state vector for each piece of an image as follows: Let an image piece, p_1 , have $K = (k_1 + k_2)$ pixels, where K is an integer. After imposing the pixel vector to the ABM net, k_1 is the number of neurons excited and k_2 is the number of neurons grounded. A neural state vector can be constructed to represent such a configuration, which k_1 components being 1, and k_2 components being 0.
- e) Constructing a connection space and the first connection vector within this space as follows: all neuron configurations together form a space, the configuration space. All neuron connections together form a space, the connection space. Now make the configuration vector = connection vector = p_1 , which results in the first synaptic connection matrix element.

- f) Calculating the rest of the matrix elements are based on a distance in the configuration space, either the Hausdorff distance or L1 distance or L2 distance, and the first matrix element calculated in the last step. Many connection vectors will be in a group with a distance of 1 from p1. Many vectors will be in a group with a distance of 2 from p1. A connection represented by p1 is assigned the largest value. Those connections in the group of distance 1 will have small values; those connections in the group of distance 2 will have even smaller values, After a certain distance, the connection matrix elements will be 0. There are many ways to generate these matrix elements from the first matrix element. The present invention covers all possible combinations of such a generating method.
- g) Constructing a Markov chain after the connections are established.
- h) Adding a mapping for each connection as follows: for each connection, in addition to the synaptic connection weight, a mapping over each connection is established. Let k1 be a number of neurons in the original k1 order connection generated by p1, then this mapping maps from the k1 neuron to the k1 pixel value which excited these neurons. This completes the connection for the original segment p1.
- i) Adding restrictions to these mappings associated to each connection: an image segment, p1, generates many connections. If a neuron in this connection is one of the original k1 neurons in p1, then this neuron is mapped into the corresponding pixel value; otherwise, this neuron is mapped into 0. This completes the mappings of all connections generated by this segment, p1.

38. (Currently amended) The process of Claim 35, wherein the step of Classifying at least one target image based on the invariant distribution function of the trained ABM comprises:

- a) Imposing an image to be classified on the ABM Markov chain.
- b) Letting this ABM Markov chain to settle on its invariant distribution. A distribution function is deployed to describe such a distribution.
- c) Classifying the target image based on this distribution function. This will produce triplets of image, class, and weight. Image retrieval and classification are two different sides of the same token.
- d) Presenting these triplets of image, classification, and weight as the results of the classification process. For the search process, a doublet of image and weight are displayed. The second part of the triplet is omitted because the search problem has only one class.

39. (Currently amended) The process of Claim 35, wherein the step of Classifying at least one target image based on the invariant distribution function of the trained APN comprises:

- a) Imposing an image to be classified on the ABM Markov chain.
- b) Letting this APN Markov chain to settle on its invariant distribution. A distribution function is deployed to describe such a distribution.
- c) Classifying the target image based on this distribution function. This will produce triplets of image, class, and weight.
- d) Comparing the input-vector and the APN-connection-vector modifies this weight. All connection vectors together form a vector space. A distance, either L1 distance or L2 distance, can be defined in this space. The basic idea is the new weight will be directly proportional to the old weight and inversely proportional to this distance. The present invention covers all functions of obtaining the new weight:

$$\text{New weight} = f(\text{old weight, distance}).$$

This will produce a new set of triplets of image, classification, and weight.

- e) Presenting these triplets of image, classification, and weight as the results of the classification process. For the search process, a doublet of image and weight are displayed. The second part of the triplet is omitted because the search problem has only one class.